Integrating Technology and Pedagogy in Elementary Education from the Teachers' Perspective

Sitti Sakiyah Asbar[a*], Annisa Syauqina Kadar[b]

[a*]Bosowa University, South Sulawesi/Makassar, Indonesia, asbarkiki@gmail.com

[b]Bosowa University, South Sulawesi/Makassar, Indonesia, annisasyauqina@gmail.com

*Correspondence: annisasyauqina@gmail.com

Abstract

The adoption of technology in elementary education has transformed teaching by improving lesson delivery and creating more engaging ways to support student learning. This study explores elementary school teachers' understanding of the relationship between pedagogical content knowledge and technology in practice. Data were collected through interviews and classroom observations involving eight elementary school teachers who actively used technology. Findings showed that teachers viewed technology as an essential resource that enhanced interactivity, made abstract content more concrete, and made learning enjoyable. Teachers reported that technology improved student participation and comprehension, while also supporting lesson customization for learners with different abilities. Despite these benefits, challenges such as limited facilities, unstable internet access, and extended preparation time were noted. Teachers emphasized that reliable infrastructure and continuous professional development were critical to strengthening technology use. This study concludes that technology, when effectively embedded in pedagogy, not only enhances engagement but also contributes to a shift toward more student-centered frameworks, demonstrating that such pedagogical shifts are already occurring in everyday elementary classrooms.

1. Introduction

The integration of technology in education has become a global phenomenon that continues to reshape pedagogical practices and learning environments. The adoption of digital resources, interactive software, and online learning systems has transformed classrooms from teacher-centered settings into more flexible and learner-centered spaces. Numerous studies have documented that technology, when pedagogically integrated, enhances student engagement, motivation, and learning outcomes (Baidoo & Luneta, 2024; Panakaje et al., 2024; Sudirman et al., 2023; Fatihah et al., 2024). Despite these benefits, the integration of technology into classroom practice remains complex. Teachers frequently face challenges related to limited infrastructure, inadequate training, and insufficient institutional support, which influence how technology is enacted in instructional contexts (Alkhawaldeh & Menchaca, 2014). Research also indicates that teachers' beliefs, self-efficacy, and school climate play a critical role in determining whether technology integration is meaningful or merely superficial (Ertmer & Ottenbreit-Leftwich, 2019; Perkmen, 2024).

In the context of elementary education, technology integration holds particular significance due to young learners' developmental need for concrete, visual, and interactive learning experiences. Previous studies show that multimedia resources, digital applications, and interactive learning environments support elementary students' motivation, attention, and conceptual understanding (Dwidarti et al., 2025; Nurhasanah et al., 2025; Sihombing et al., 2024). Technology has also been shown to foster early digital literacy, creativity, and problem-solving skills when integrated with

appropriate pedagogical strategies (Fadhli et al., 2023). However, effective technology integration extends beyond access to digital tools. It requires alignment between technology, pedagogy, and content knowledge, as conceptualized in the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006). Studies across different contexts emphasize that teachers' professional competence, instructional beliefs, and contextual support significantly shape how technology is used in classrooms (Ertmer & Ottenbreit-Leftwich, 2019; Istiana & Widodo, 2023).

Although a growing body of research has examined educational technology integration, much of the existing literature focuses on student outcomes, policy implementation, or specific digital tools. Less attention has been given to elementary school teachers' perspectives on how technology integration reshapes pedagogy in everyday classroom practice, particularly within the Indonesian context (Wang, 2024; Istiana & Widodo, 2023). Teachers are not merely implementers of technology but active agents who interpret and adapt pedagogical innovation in response to classroom realities.

This study was conducted in an elementary school in Makassar, Indonesia, where teachers are increasingly encouraged to integrate digital tools despite infrastructural and institutional constraints. Therefore, this study aims to explore elementary school teachers' perspectives on the integration of technology and pedagogy, focusing on instructional strategies, perceived benefits and challenges, and pedagogical role shifts in classroom practice. The study is guided by the following research questions:
a) How do elementary school teachers use technology in their pedagogical practices?
b) What benefits and challenges do teachers experience when integrating technology with pedagogy?
c) In what ways has technology influenced teachers' roles and teaching strategies in the classroom?

This study contributes theoretically by foregrounding teachers' lived pedagogical experiences in elementary classrooms and practically by informing educators and policymakers about the support required for meaningful and sustainable technology integration in primary education.

2. Literature review

2.1 Technological Pedagogical Content Knowledge (TPACK) Framework

The Technological Pedagogical Content Knowledge (TPACK) framework, introduced by Mishra and Koehler (2006), provides a comprehensive lens for understanding how teachers integrate technology into instructional practice. The framework emphasizes the intersection of three core domains: content knowledge, pedagogical knowledge, and technological knowledge. Rather than treating technology as an additional tool, TPACK conceptualizes technology integration as a transformative process that reshapes pedagogy and content delivery. Research has highlighted that effective technology integration occurs when teachers are able to align digital tools with instructional goals and pedagogical strategies (Ertmer & Ottenbreit-Leftwich, 2019). Studies further suggest that teachers' confidence, beliefs, and school culture play a crucial role in determining whether technology is used meaningfully or merely for administrative purposes (Perkmen, 2024). Within this framework, technology functions not as an add-on, but as an integral component of instructional design that supports student-centered learning.

2.2 Technology Integration in Elementary Education

Technology integration in elementary education has gained increasing attention due to its potential to support young learners' cognitive and developmental needs. Previous studies indicate that digital tools, such as multimedia resources, interactive applications, and educational games, enhance student engagement, motivation, and conceptual understanding in primary classrooms (Baidoo & Luneta, 2024; Dwidarti et al., 2025; Nurhasanah et al., 2025). In elementary contexts, technology supports visualization and concrete representation of abstract concepts, which is particularly beneficial for young learners. Systematic reviews also highlight that technology integration fosters communication, creativity, and problem-solving skills while contributing to early digital literacy development (Sihombing et al., 2024; Fadhli et al., 2023). However, research consistently reports challenges related to limited infrastructure, unstable internet access, and insufficient institutional support, especially in resource-constrained settings (Istiana & Widodo, 2023; Lestari et al., 2024).

2.3 Teachers' Perspectives on Technology Integration

Teachers' perspectives play a central role in shaping how technology is enacted in classrooms. Studies show that teachers' beliefs, self-efficacy, and professional experiences significantly influence their willingness to adopt and sustain technology integration (Ertmer & Ottenbreit-Leftwich, 2019; Perkmen, 2024). Teachers who perceive technology as pedagogically meaningful are more likely to

implement interactive and student-centered practices. Research conducted in various contexts reveals that teachers appreciate technology's ability to enhance participation and motivation but often express concerns regarding workload, preparation time, and lack of technical support (Brown & Gallo, 2024; Pfister & Paljevic, 2024). Studies conducted in Indonesia indicate that teachers generally hold positive attitudes toward technology integration and recognize its potential to enhance student engagement and learning experiences. However, teachers' perspectives are often shaped by contextual realities such as limited infrastructure, uneven access to digital resources, and varying levels of institutional support. Istiana and Widodo (2023) report that Indonesian teachers face persistent challenges related to technological readiness, despite increasing expectations to integrate digital tools into classroom practice. Research on digital learning policies in Indonesia further suggests that systemic and contextual factors influence how teachers perceive and enact technology integration. Lestari et al. (2024) highlight that policy-driven digital initiatives do not always translate into meaningful pedagogical change at the classroom level, particularly in rural and resource-constrained settings. These conditions require teachers to adapt technology use creatively while negotiating workload demands and pedagogical constraints.

Although existing studies provide valuable insights into technological challenges and policy implementation in Indonesia, teachers' lived pedagogical experiences in elementary classrooms remain underexplored. In particular, there is limited research examining how Indonesian elementary school teachers interpret technology integration in relation to their instructional roles, pedagogical strategies, and classroom practices. This gap underscores the need for the present study, which foregrounds teachers' perspectives to better understand technology integration as a pedagogical process within the Indonesian elementary education context.

2.4 Empirical Studies on Technology Integration in Indonesia

Several studies conducted in Indonesia highlight both the opportunities and challenges of technology integration in educational settings. Research by Istiana and Widodo (2023) emphasizes infrastructural constraints in early childhood and elementary education, while Lestari et al. (2024) point to policy-related challenges affecting educational equity in rural schools. These findings suggest that although Indonesian teachers recognize the pedagogical value of technology, contextual limitations significantly shape how integration occurs in practice. However, existing studies rarely foreground teachers' lived pedagogical experiences, particularly in elementary classrooms.

2.5 Theoretical Framework and Research Gap

Drawing on the TPACK framework and prior studies on technology integration, this study situates technology integration as an interaction between pedagogical practices, digital tools, and teachers' professional beliefs within specific contextual conditions. While previous research has largely focused on student outcomes or tool effectiveness, fewer studies have examined how elementary school teachers experience pedagogical change through technology integration, particularly in Indonesian contexts. Table 1 summarizes key previous studies on technology integration, indicating that although prior research has extensively addressed learning outcomes, instructional tools, and policy dimensions, limited attention has been given to elementary school teachers' lived pedagogical experiences. This gap underscores the need for the present study, which foregrounds teachers' perspectives to better understand how technology integration reshapes instructional roles, supports differentiated learning, and introduces new pedagogical dynamics in elementary classrooms.

Table 1

Summary of Previous Studies on Technology Integration

Author(s)	Context	Focus	Key Findings	Gap
Baidoo & Luneta (2024)	Secondary education	Blended learning	Improved achievement	Focus on outcomes, not teachers' perspectives
Dwidarti et al. (2025)	Elementary	Multimedia learning	Enhanced engagement	Limited pedagogical analysis
Istiana & Widodo (2023)	Indonesia (ECE)	Technology challenges	Infrastructure constraints	Teachers' lived experiences underexplored

Ertmer & Ottenbreit-Leftwich (2019)	Various contexts	Teacher beliefs	Beliefs shape integration	Limited elementary focus

This gap underscores the need for the present study, which foregrounds teachers' perspectives to understand how technology integration reshapes pedagogy in elementary classrooms.

2.6 Conceptual Framework

Based on the identified theoretical framework and research gap, this study proposes a conceptual framework to explain how technology integration operates in elementary classroom practice. Grounded in the Technological Pedagogical Content Knowledge (TPACK) framework, technology integration is conceptualized as an interaction between pedagogical practices, digital tools, and teachers' professional beliefs within specific contextual conditions. Teachers' perspectives serve as a central mediating element that shapes how technology is selected and implemented to support pedagogical goals. Through this mediation, technology integration influences three interrelated pedagogical dimensions: student engagement and motivation, instructional differentiation, and pedagogical role shifts toward more student-centered learning. Contextual factors, including infrastructure, institutional support, and teachers' workload, further enable or constrain the sustainability of technology-integrated practices. The proposed framework reflects an interactional and exploratory relationship rather than a linear causal model, aligning with the qualitative nature of the study and guiding data collection and thematic analysis.

Figure 1

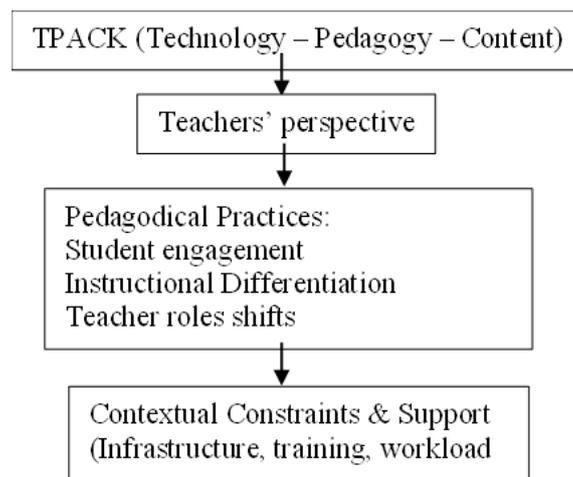*Conceptual framework based on the TPACK model*

Figure 1. Conceptual framework based on the TPACK model illustrating how teachers' perspectives mediate the interaction between technology integration, pedagogical practices, and contextual factors in elementary classrooms.

3. Method

3.1 Research Design

This study employed a descriptive qualitative research design with a case study orientation. The design was selected to explore elementary school teachers' perspectives and experiences regarding the integration of technology and pedagogy in everyday classroom practice. A qualitative approach was considered appropriate as the study sought to gain an in-depth understanding of teachers' interpretations, practices, and perceived challenges rather than to measure causal relationships or test hypotheses. The study was guided by an exploratory and interpretive perspective, consistent with the conceptual framework grounded in the TPACK model.

3.2 Research Setting

The study was conducted at Mallengkeri Bertingkat 1 Elementary School, located in Makassar, Indonesia. The school is a public elementary school that has begun integrating digital tools into classroom instruction despite facing infrastructural and institutional constraints. This setting was

selected because it represents a typical urban public school context in Indonesia where technology integration is increasingly encouraged at the policy level but unevenly implemented in daily practice.

3.3 Participants

The participants of the study consisted of eight elementary school teachers who actively integrated technology into their classroom instruction. The teachers represented different grade levels and subject areas, allowing for varied perspectives on technology integration across instructional contexts. Participants were selected using purposive sampling, with the following criteria: (1) being an active elementary school teacher, (2) having experience using digital tools for instructional purposes, and (3) willingness to participate in interviews and classroom observations. To maintain confidentiality, participants were assigned pseudonyms and referred to using numerical identifiers (e.g., Teacher 1, Teacher 2).

3.4 Data Collection

Data were collected through semi-structured interviews and classroom observations. Each participating teacher was interviewed once, with interview sessions lasting approximately 40–50 minutes. The interview guide consisted of open-ended questions focusing on teachers' experiences, pedagogical strategies, perceived benefits and challenges of technology integration, and changes in instructional roles. Classroom observations were conducted to complement interview data and to capture how technology integration was enacted in practice. An observation protocol was used to document teacher–student interactions, types of digital tools employed, levels of student engagement, and classroom dynamics during technology-integrated lessons. Field notes were taken during each observation to record contextual details and reflective insights.

3.5 Data Analysis

Data analysis followed a thematic analysis approach. Interview transcripts and observation field notes were analyzed through an iterative coding process. Initial coding involved identifying meaningful units related to technology use, pedagogical practices, and teachers' perspectives. These codes were then grouped into broader themes reflecting patterns across participants. The final themes were aligned with the conceptual framework, focusing on student engagement, instructional differentiation, pedagogical role shifts, and contextual constraints. Data from interviews and observations were triangulated to enhance analytical depth and consistency.

3.6 Trustworthiness

To ensure the trustworthiness of the study, several strategies were employed. Credibility was established through data triangulation between interviews and classroom observations, as well as member checking, in which participants reviewed preliminary interpretations of the findings. Transferability was supported by providing detailed descriptions of the research context and participants. Dependability was enhanced by maintaining a clear audit trail of data collection and analysis procedures, while confirmability was addressed by grounding interpretations in participants' direct quotations and observational evidence.

3.7 Ethical Considerations

Ethical considerations were carefully addressed throughout the study. All participants provided informed consent prior to data collection and were informed of the voluntary nature of their participation. Participants were assured of anonymity and confidentiality, and no identifying information was included in the reporting of findings. Data were securely stored and used solely for research purposes.

4. Results and Discussion

4.1 Results

This section presents the findings of the study based on interview and classroom observation data. The results are organized according to the research questions and emerging themes from the thematic analysis.

Teachers' Use of Technology in Classroom Practice

Teachers reported using various digital tools to support lesson delivery and student engagement. Commonly used technologies included animated PowerPoint slides, instructional videos, interactive quizzes, and simple digital games. Classroom observations confirmed that these tools were integrated

primarily during lesson explanations and practice activities. One teacher explained: *"Kalau hanya dijelaskan lewat buku, anak-anak cepat bosan. Tapi kalau pakai video atau gambar bergerak, mereka lebih fokus dan cepat paham."* (Teacher 2)

During classroom observations, the use of short videos and animated slides was found to help students visualize abstract concepts, particularly in science and language lessons. Teachers typically paused videos to ask guiding questions, indicating an effort to integrate technology with pedagogical interaction rather than passive viewing.

Technology and Student Engagement

All participants emphasized that technology increased students' attention, enthusiasm, and willingness to participate. Teachers observed that students were more responsive during lessons that involved digital media compared to textbook-based instruction. As one teacher stated: *"Kalau ada kuis digital, kelas langsung hidup. Anak-anak berebut mau jawab."* (Teacher 4) Observation data showed that students appeared more attentive during technology-supported activities, with increased hand-raising, verbal responses, and peer interaction. Shy students were also observed participating more actively during digital quizzes, suggesting that technology reduced anxiety and fear of making mistakes.

Instructional Differentiation through Technology

Teachers described how technology enabled them to accommodate students with varying abilities. Struggling students benefited from repeated exposure to videos and visual explanations, while higher-achieving students were given access to additional digital tasks. One teacher noted: *"Kalau ada anak yang belum paham, saya ulang videonya. Mereka bisa lihat berkali-kali tanpa malu."* (Teacher 3). Classroom observations supported this claim, showing that some students replayed videos independently while others engaged in extension activities. This flexibility allowed teachers to manage mixed-ability classrooms more effectively.

Pedagogical Role Shifts

Several teachers reflected on changes in their instructional roles following technology integration. Rather than acting as the sole source of knowledge, teachers described themselves as facilitators who guided student interaction and discussion. One participant explained: *"Sekarang saya tidak terlalu banyak ceramah. Anak-anak lebih aktif, saya hanya mengarahkan."* (Teacher 1). Observation data revealed increased student-centered interaction during technology-based activities, with teachers circulating the classroom, offering feedback, and prompting discussion rather than leading extended explanations.

Table 2

Summary of Main Themes from the Findings

Theme	Description	Data Sources
Technology as Instructional Support	Digital tools used to enhance explanation and visualization	Interviews, Observations
Student Engagement	Increased motivation, participation, and confidence	Interviews, Observations
Instructional Differentiation	Flexible pacing and task adaptation	Interviews
Pedagogical Role Shift	Movement toward facilitative teaching	Interviews, Observations

4.2 Discussion

The findings of this study indicate that technology integration in elementary classrooms extends beyond the use of digital tools and contributes to meaningful pedagogical change. Consistent with the TPACK framework, teachers in this study demonstrated an awareness of aligning technology with pedagogical strategies to support student engagement and learning. Rather than using technology as a standalone resource, teachers integrated digital tools to facilitate interaction, visualization, and differentiated instruction. The increased student engagement observed in this study aligns with previous research highlighting the motivational benefits of technology integration (Baidoo & Luneta, 2024; Dwidarti et al., 2025). However, unlike studies that focus primarily on learning outcomes, the present findings emphasize teachers' perspectives as central to understanding how engagement is fostered in

everyday classroom practice. This supports Ertmer and Ottenbreit-Leftwich's (2019) argument that teachers' beliefs and instructional decisions significantly shape meaningful technology use.

The role of technology in supporting instructional differentiation also echoes earlier studies on digital learning flexibility (Fadhli et al., 2023; Nurhasanah et al., 2025). This study extends existing literature by demonstrating how elementary teachers use technology pragmatically to manage mixed-ability classrooms, reinforcing the relevance of TPACK as a practical framework rather than a theoretical abstraction. Importantly, the pedagogical role shifts reported by teachers reflect a move toward student-centered learning, a transition often discussed normatively in the literature but less frequently documented in practice. The findings suggest that technology serves as a catalyst for this shift, enabling teachers to adopt facilitative roles aligned with contemporary pedagogical expectations. For teachers, the findings highlight the importance of selecting digital tools that align with pedagogical goals rather than focusing solely on novelty. School leaders should provide structured support, including time allocation and collaborative planning opportunities, to reduce teacher workload. Policymakers are encouraged to consider infrastructure development alongside professional development to ensure sustainable technology integration. The study contributes theoretically by illustrating how the TPACK framework operates in elementary classroom practice through teachers' lived experiences. By foregrounding teachers' perspectives, the study demonstrates that technology integration is an interactional process shaped by pedagogy, beliefs, and context. This study is limited by its focus on a single school and a small number of participants, which may affect transferability. Future research may involve multiple schools or longitudinal designs to explore how technology-integrated pedagogical practices evolve over time.

4.   Conclusion and recommendation

This study explored elementary school teachers' perspectives on the integration of technology and pedagogy in classroom practice. Addressing the research questions, the findings show that teachers use digital tools primarily to enhance student engagement, support instructional differentiation, and facilitate shifts toward more student-centered teaching practices. Technology was perceived not merely as an instructional aid, but as a pedagogical resource that reshapes teachers' instructional roles and classroom dynamics. The study further reveals that teachers' perspectives play a central mediating role in determining how technology is meaningfully integrated. While digital tools supported motivation, participation, and flexibility in mixed-ability classrooms, their effectiveness was influenced by contextual factors such as infrastructure availability, institutional support, and workload demands. Theoretically, this study contributes to the body of knowledge on educational technology by providing empirical evidence of how the TPACK framework operates in elementary classrooms through teachers' lived experiences, particularly within the Indonesian context. The findings demonstrate that pedagogical shifts toward student-centered learning are not merely aspirational but are already occurring in everyday practice when technology is pedagogically aligned. This study has several limitations that should be considered when interpreting the findings. The research was conducted in a single elementary school with a limited number of participants, which may affect the transferability of the results to other contexts. In addition, the study focused on teachers' perspectives and classroom observations without examining students' learning outcomes in depth. These limitations provide opportunities for further investigation.

Recommendations

For teachers, the findings suggest the importance of selecting digital tools based on pedagogical objectives rather than novelty. Teachers are encouraged to integrate technology in ways that promote interaction, visualization, and differentiated instruction. For school principals, providing structured support such as collaborative lesson planning time, peer sharing of digital teaching resources, and basic technical assistance can help reduce teachers' workload and sustain meaningful technology integration.

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